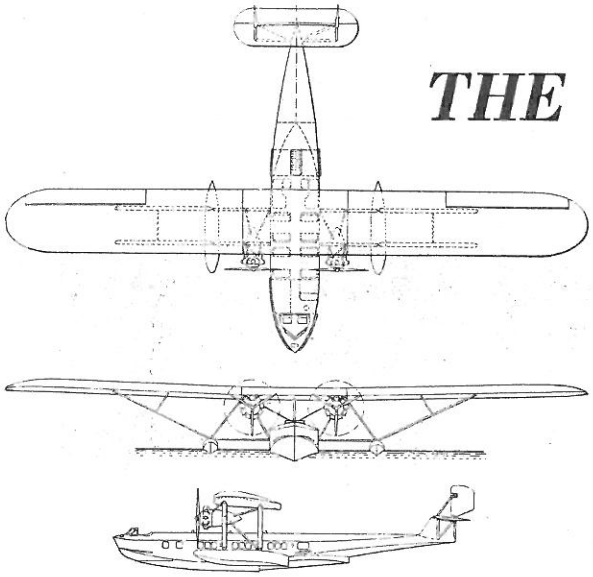
AVIATION
January 11, 1930



THE CONSOLIDATED "Commodore" FLYING BOAT

A Description of the Commercial Adaptation of the Navy XPY-1

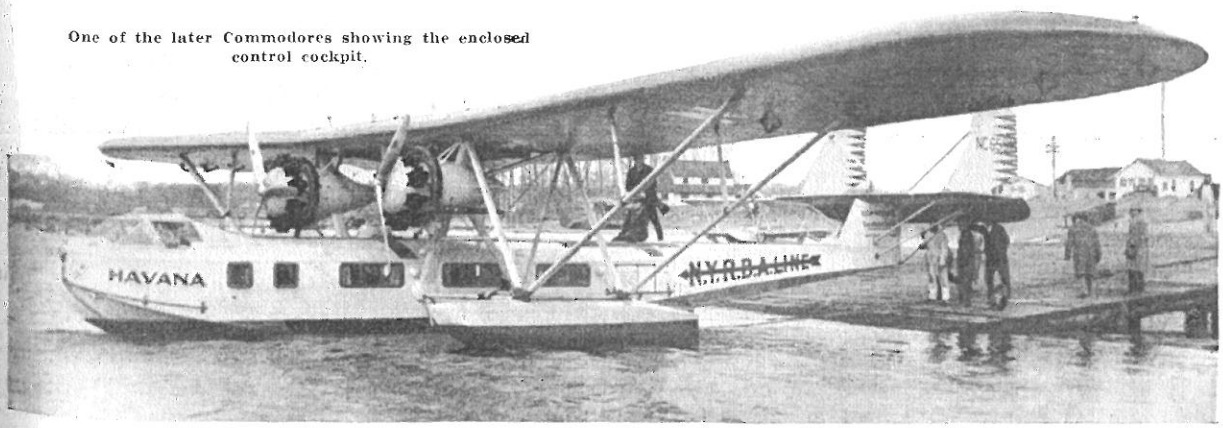
By LESLIE E. NEVILLE
Technical Editor of AVIATION

THE CONSOLIDATED COMMODORE, Model 16, largest commercial flying boat to be built in numbers in the United States, is now under production at the plant of the Consolidated Aircraft Corporation, Buffalo, N. Y. A production unit of twelve of these craft is now under way to fill an order of the New York Rio and Buenos Aires Line, Inc., which is now operating on regular schedule between South American ports and is planning to extend its service to New York. Several of the Commodores have been delivered and are now in South American service.

The Commodore is a central hull, monoplane flying boat powered with two Pratt & Whitney Hornet engines rated 575 hp. at 1,950 r.p.m. The craft has a wing span of 100 ft., a length of 61 ft. 9 in. and a height on handling gear of 16 ft. Its weight empty is 9,785 lb. and its gross weight 17,600 lb.

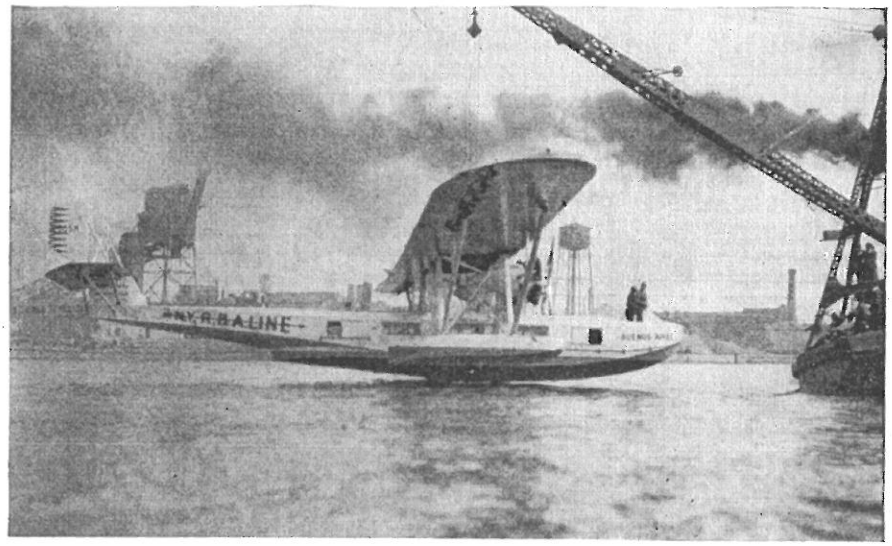
IN DESIGN the Commodore is the commercial adaptation of the XPY-1 Navy patrol boat built by Consolidated under a contract awarded as a result of a design competition. It was designed by I. M. Laddon, assisted by Frederic Flader and J. L. McClane. Hull lines were developed for the original flying boat by Captain Holden C. Richardson of the Bureau of Aeronautics, Navy Department.

Wind tunnel tests of a model of the consolidated XPY-1 showed a maximum L/D ratio of 11.4. The



One of the later Commodores showing the enclosed control cockpit.

advisability of moving the engines to a point above the wing was considered at this time and the model was modified with this idea in mind. Tests of the modified model showed that the maximum L/D value was reduced to 7.5 by this change and the drag at all angles of attack was increased to a prohibitive extent. The L/D ratio of the original model is attributed to the high aspect ratio (8.9) monoplane wing and to the general cleanness of design. Placing the power plants above the wing was abandoned also because it was believed that it would result in an increased landing speed due to the fact that the propeller disk areas would block off a relatively important percentage of the air reaching the wing when the engines were throttled.



A photograph taken during the launching of the first of the Commodores in Buffalo

Model basin tests of the Admiral or XPY-1 indicate a peak requiring maximum power at 33 per cent of the getaway speed or approximately 20 mi. per hour. In actual tests this peak is not apparent, acceleration being uniform and rapid until take off. With a gross weight of 13,600 lb. the XPY-1 takes off in 31 sec. in still air and under the same conditions with the gross weight increased to 16,000 lb. the craft requires 45 sec. to take off. Commodore performance is on this basis.

Practically all of the aerodynamic features of the XPY-1 are retained in the Commodore, the modifications being mainly structural. A crown deck has been substituted for the cylindrical deck of the patrol boat to provide additional headroom for passengers and sufficient height for the possible installation of sleeping berths.

The monoplane wing is of constant chord, this value being 11 ft. 6 in. throughout the span. A Gottingen 398 airfoil section is employed, affording a good combination of maximum L/D ratio and spar depth for such a long span. Ailerons are of a balanced type and have a total area aft of the hinge of 110 sq.ft. The 1,110 sq.ft. of wing area is so distributed that 207 sq.ft. constitute the center section and the remainder the two wing panels. The angle of incidence is + 4 deg., while the dihedral angle is 2 deg.

In order to facilitate manufacture of the first Commodore the hull lines were laid down to full scale on a smoothly finished floor board 75 ft. long and 25 ft. wide in the engineering department. From this layout, full size templates were made of all of the necessary sections and sent directly into the shop for use. This practice has certain obvious advantages and it is apparently an adaptation of the "mould loft" used in the construction work of ship building firms.

PROBABLY the outstanding features in the construction of the Commodore are the extensive use of forgings and the open sections used in the structure, the advantages of open section construction being accessibility of members for riveting and elimination of the possibility of internal corrosion. Particular care has been taken to avoid hammering of the skin, the only important irregular shape being found at the nose. Forming of this member is done on a Pettingill No. 2 hammering machine. Small parts are hand hammered. It is noteworthy that a maximum of athwart-ship bracing is employed in the structure and a large proportion of the weight of the floor system is carried by longitudinal members which also contribute to the general strength of the hull.

WITH THE EXCEPTION of the fabric covering the wing of the Commodore is built entirely of metal, Aluminum Company of America designation 17ST alloy being used. Spars are of the Warren truss type having extruded bulb T sections for the flanges and back to back channels for the web members. These members are separated at the center by spacers. The flanges both top and bottom are joined by lighter aluminum alloy extruded trusses which act as drag truss compression members. Double drag bracing is used with one pair of wires in the plane of the upper flange and one in the plane of the lower. The T section flanges are finished with a cover plate of extruded aluminum alloy.

Ribs are also of Warren truss type formed from strip stock rolled to channel section. Connection between the flange and web members is made by means of a small + shaped aluminum alloy forging, fitting inside of the channels and providing anchorage points for four 1-in. diameter through rivets. The ribs thus constructed weighing approximately 2 lb. each and under low and high incidence static tests withstood substantial overloads. The main beams are built up on jigs by means of squeeze riveting. Hand squeezers are used whenever possible in final assembly.

One fuel tank, 315 gal. capacity, is set between the spars in each of two compartments of the center section. Oil tanks, each having 25 gal. capacity, are placed in each end of this section. The drag truss is made up of top and bottom chord members of extruded bulb T section, while the web members are extruded bulb angle sections in Warren truss form. Center section ribs are standard. This structure is protected by red oxide and zinc chromate of Navy department specification, while the final finish is lacquer or aluminum enamel.

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Fittings are of chrome molybdenum steel and all sheet metal of this specification used in fittings is heat treated to 125,000 lb. per sq.in. TS after welding. Following the heat treating cadmium plating is applied.

External bracing of the wings consists of streamline aluminum alloy tubing. The forward outboard strut is drawn from a 5 in. OD aluminum alloy tube of 0.134 in. gauge material. It is said to be the largest member of this type thus far used in aircraft production. Two other special sizes of streamline tubing are employed, both being drawn from 4 in. OD aluminum alloy tube of 0.148 and 0.09 in. gauge respectively. In addition to these three sizes, two Aluminum Company standard sizes of streamline tubing are used.

THE HULL, under present production methods, is built in inverted form. Bulkheads are set in place in jigs and all of the structural members of the bottom are put in place in this position. After the bottom plating has been applied, the hull is turned to normal position and the sides and upper structural members are added. This is followed by the application of the plating for the sides and the top. Bulkheads of 0.030 plate are provided at appropriate intervals, the sheet material being bordered by extruded bulb angle section aluminum alloy. Extruded longitudinal stringers of bulb angle section are riveted to the deck and bottom plating on approximately 7-in. centers throughout the deck area and much closer than this along the bottom. These longitudinal stringers are supported in turn by intermediate floor frames built up of extruded angle and channel section members in the form of a truss. These floor frames are supported at five points, the two chines, the two keelson plate girders and the central keel truss. The hull analysis was made in accordance with naval architectural methods basing external loads on three criteria:

1—Hogging condition with the crest of the wave amidships.
2—Sagging condition with the trough of the wave amidships.
3—Landing condition with the load concentrated on the bottom forward of the step.

These were the determining factors in the thickness of plating, spacing of longitudinal stringers, design of the floor frame trusses, the keelsons and the central keel truss.

In the forward portion of the hull there are four floor frames between each set of bulkheads. These floor frames are formed and assembled in jigs. They are made up of extruded bulb angle section members with two main trusses at the bottom. Plate girders are set 11 in. on each side of the center. The skin or plating is applied with splices staggered and is made water tight by the application of cotton tape, soap and soya bean compound.

In the process of fabrication the skin is held in place by small L-hooks and wedge shape blocks, making it possible to drill the plating and structural members at the same time. The blocks are easily removable for riveting the skin to the structure. Following the completion of the bottom plating the completed hull is turned over as previously mentioned and at this point it is filled with water approximately to the lower chine as a test for water tightness.

The watertight splices in the plating are made up of a double row of staggered rivets. All contacting surfaces are coated with varnish and assembled while the varnish is still wet.

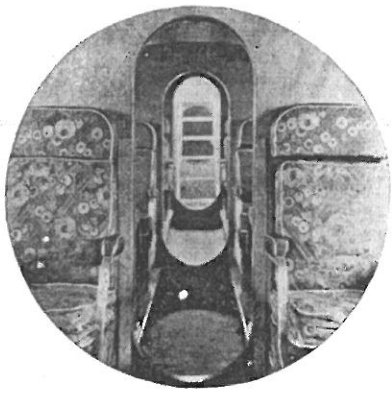
No break is made in the structure to provide for the step, this unit being built up by a V-shaped form piece, while the keelson girders and chine members are carried through. The stringers are built down to form the step.

Diagonal members run from top to bottom of the main bulkhead and connect with fittings at the attachment points of the structure. They are reinforced by steel fittings riveted within the skin and are double or single angle members, depending on the stresses to which they are subjected.

Formed members of bulkheads and belt frames are cold worked and in heat treated condition.

THROUGHOUT THE CONSTRUCTION section sizes have been standardized to as high a degree as practicable, the result being that stock sizes are relatively few in number.

In addition to the five sizes of streamline tubing previously mentioned, two sizes of extruded bulb T section material are used in the wing structure. These are $2\frac{3}{8}$x$1\frac{1}{2}$x$\frac{3}{16}$ in. and $2\frac{1}{4}$x$1\frac{1}{2}$x$\frac{1}{8}$ in. Two sizes of plain angles, $\frac{3}{4}$x$\frac{3}{4}$x$\frac{3}{32}$ in. and 1x1x$\frac{3}{32}$ in., three sizes of bulb angle section material, $\frac{7}{8}$x$\frac{9}{16}$, 1x$\frac{11}{16}$, and $1\frac{5}{16}$x$\frac{3}{4}$, are used. The channel sections are three in number, $\frac{7}{8}$x$\frac{3}{8}$x$\frac{1}{16}$ in., $\frac{7}{8}$x$\frac{3}{8}$x$\frac{3}{32}$ in. and 1x$\frac{1}{2}$x$\frac{3}{32}$ in. Two 1x1 plain angles formed by extrusion are used for the after part of the keel and two extruded plain angles are employed for the floats. The top and side plating of the hull is 0.030 sheet, while the bottom plating forward of the step is 0.064 and aft of the step is 0.040. Two sizes of rivets are used in the hull; $\frac{1}{8}$ in. in sides and top plating and $\frac{3}{16}$ in. in bottom



Left: One of the day bed cabins. Center: View through the central passage. Right: Seats in the forward compartments.

plating. Riveting is relatively easy on account of the open section material employed. Forgings are used for strut ends at the points of wing attachment.

The mooring pendant is $\frac{9}{16}$ in. diameter bronze cable attached to the keel at bulkhead No. 2, and the anchor cable, which is 150 ft. in length, is $\frac{5}{16}$ in. diameter bronze and is equipped with fittings at 25 ft. intervals by which the pendant can be attached. A cork canvas covered bumping pad is rigidly attached to the nose.

STABILIZING FLOATS, whose center lines are located about 14 ft. from that of the hull, are structurally similar to the hull and each is divided into three water tight compartments by means of bulkheads. An unusual feature of these floats is that they have no drain plugs. Each compartment is fitted with a $\frac{1}{2}$ in. tube running from the bottom to a point $1\frac{1}{2}$ in. above the deck. A hose may be attached to the abutting pipes, making it possible to pump up the compartments individually.

Right and left floats are interchangeable and are attached to struts projecting from either side of the hull and also providing a point of support for the external bracing struts of the wing. Thus the flotation system is so tied into the external wing bracing that, while the overall span is large, the overhang at the wing tips is less than $1\frac{1}{2}$ chord lengths. Each float is held in place by means of eight studs and can be easily and quickly removed without disturbing the wing bracing. The ends of the projecting struts are squared to provide bearing area for the floats and squared ends are filled with cork and painted to provide water tightness.

THE CABIN is 8 ft. 5 in. wide and has 6 ft. head room. The hull is entered through a hatch in the deck and is divided into several compartments. The subdivision furthest aft, which is directly accessible by means of the companionway leading from the hatch, is devoted mainly to mail, one compartment being provided on each side of the companion ladder, and the combined capacity of the two being 125 cu.ft. Sliding hatch covers are also built into the side of the hull to facilitate loading of mail. The capacity of the two rear mail compartments is 200 cu.ft. All bulkheads aft of the entrance compartment are fitted with apertures through which it is possible to gain access to the tail post for inspection.

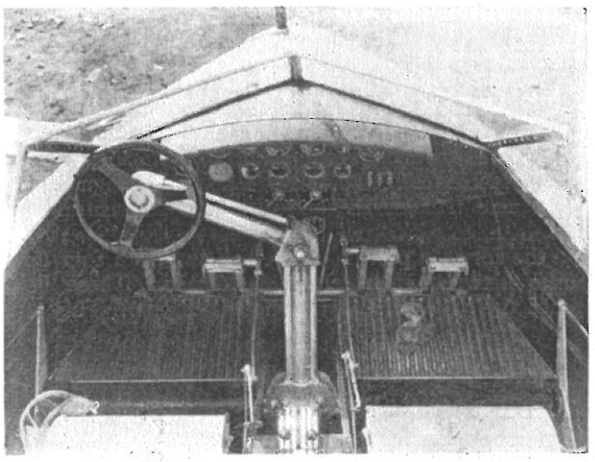
Forward of the step are three passenger compartments, each $73\frac{1}{4}$ in., providing a total capacity of twenty persons. There are three windows in the outer wall of each compartment and these windows are permanently closed. Ventilation is provided by circular openings with semi-spherical air scoops on the outer surface of the hull. Provision to vary the area of the openings is made through the use of an internally mounted metal semi-sphere controlled by a shaft having a knurled knob in the cabin. There are two inlet and two outlet openings in each compartment, two in the deck and the other two in the side plating of the hull. The ventilators for the forward portion of each compartment open toward the rear and provide suction, drawing the air from the compartment, while those at the rear open forward, furnishing an inlet for fresh air. In order to prevent drafts the main current of air passes between the skin or plating of the boat and the interior lining of the compartments.

The compartment just forward of the entrance compartment is furnished with two single seats and two daybeds, one of these being on either side of the center aisle. Forward of this compartment are two others, each of which has double seats facing each other on both sides of the aisle, providing a capacity of eight passengers per compartment. Forward of these is a division in the hull, the port side of which is devoted to a washroom and radio room, while the starboard provides an additional mail or baggage compartment of 75 cu.ft. capacity. This division is separated from the control cockpit through a water tight door which can be opened from either side.

With this interior arrangement the boat has a capacity of 20 persons. Additional passenger capacity can be provided, however, by sacrificing one or more of the mail compartments.

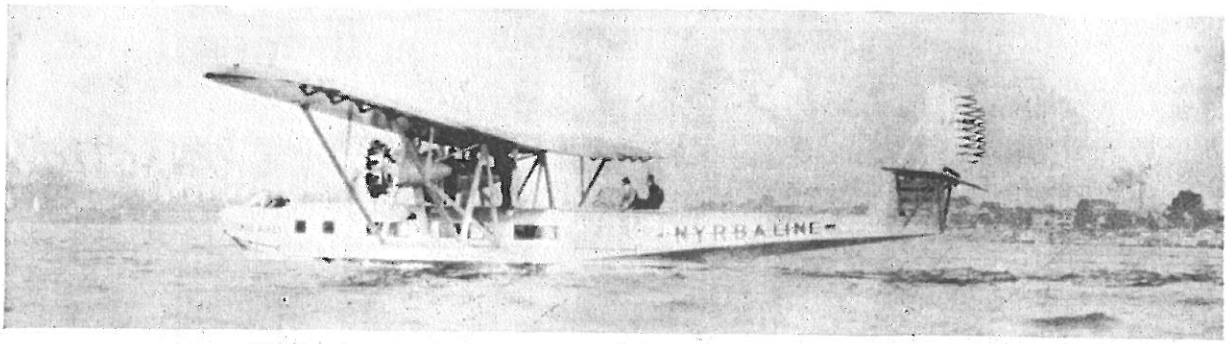
The first Commodore was outstanding in interior finish and design, the decoration being under the direction of Frederick J. Pike, a Buffalo interior decorator. A modernistic motif was developed by Mr. Pike through adaptation of the tropical colors that were to be seen along the route over which the plane is to operate. The basic tones are silver, henna and green. The inner walls, as well as the partitions, are of wallboard covered with damask, while a separate material is used in draperies with still other fabrics for upholstering of the chairs and cushions.

The walls of the salon de luxe (the compartment containing the daybeds) are covered with a Deauville rep material of pale lavender and silver, the daybeds being upholstered in turquoise damask and the seat cushions in raspberry, gold and tan stripe material. Print draperies in lemon yellow and tan have been used. In order to provide an individualistic color scheme for each cabin the central compartment has walls in green and gold with a henna color modern damask for seat cushions. The foremost cabin has chairs upholstered in a green moire, while a modernistic fabric in peach and silver is used for the cushions. Tan damask is used for the wall coverings. The central passageway through the compartments is carpeted with a jade green rug, while rugs between the seats in the cabins correspond to the color scheme of each room.



Photograph showing the open control compartment of the first commodore.

Between the seats and under the windows in each of the passenger compartments are panels for time tables, magazines or newspapers. Adjustable card or writing tables can be fitted into appropriate slots in the same manner as that employed in Pullman cars.



A photograph of the Commodore taxiing on the water during one of its trial flights.

External finish also was specially attractive in the first Commodore. A cerise wing with yellow and brown hull was chosen to harmonize best with a tropical setting.

IN THE FIRST PLANE the control cockpit was open but was later inclosed to provide protection for the pilots against weather conditions in the tropics. Both top and sides open by sliding to provide entrance to the control compartment without passing through the cabin. The pilots are seated in the bow just behind an anchor compartment in the nose which is accessible through a hatch in the deck and separated from the pilot's compartment by a bulkhead. Control is of the standard wheel and pedal type, a single swinging wheel being used. All moveable steel parts in the cockpit are made of Allegheny metal. Cables are used for the most part in the control system with a combination of these in push pull tubes being used for the ailerons. Tail surface structures are built up of extruded 17-ST spars, drag trusses and sheet duralumin ribs and are covered with fabric. An externally braced monoplane stabilizer, single unbalanced elevator and twin fins and balanced rudders above the stabilizer and elevator are employed.

The rudder travel is 30 deg. each side of neutral position, while the elevator travel is 30 deg. up and 20 deg. down. Travel of the rudder pedal is 4 in. either side of neutral, while the neutral position is 1½ in. forward of the vertical. An adjustment range of 3 in. is provided for the rudder pedal. The travel of the control column amounts to 18 in. Normal setting of the stabilizer is at 4 deg. incidence, while an adjustment range of 3 deg. up and 3 deg. down is provided.

The area of the two rudders including the balance is 40.2 sq.ft., while that of the balance on each rudder is 3.3 sq.ft. The total vertical area of the tail surfaces is 54.95 sq.ft., while the center lower fin is 14.75 sq.ft. The total horizontal area is 135.5 sq.ft., 81 sq.ft. of which constitute the stabilizer. Fin and rudder are built with a 50 per cent Gottingen section.

THE ENGINE MOUNTS are of welded steel tubing and rubber bushings are used around the engine bolts to absorb vibration. Three-blade metal propellers of approximately 9 ft. 6 in. in diameter are used on the Hornet engines and an exhaust manifold having a hot air stove and control box for interior heating purposes is also employed. Controls for the power plant, as well as the fuel system, are led through streamline fairings to the pilot's cockpit and auxiliary gasoline tanks can be installed in the hull if desirable. The port engine is provided with a 50 ampere generator which, together with an 80 ampere hour Willard storage battery, constitutes the electric generating system. The storage battery is installed in the radio compartment from which the electric system is controlled. A voltage regulator is also used in the system and is located in the radio compartment. Provision for mounting landing lights on the leading edge of the wing structure also has been made.

Each Commodore is provided with a handling truck to be used when the plane is on land for overhauling. This truck provides mounting for two 44 in. x 10 in. wheels forward and one tail wheel.

Specifications as furnished by the manufacturer are:

Type	Monoplane flying boat
Span	100 ft.
Overall Length	61 ft. 6 in.
Overall Height	14 ft. 2 in.
Wing Airfoil	Gottingen 398
Chord	11 ft. 6 in.
Incidence	+4 deg.
Dihedral	2 deg.
Aileron	Frise Type
Tail Airfoil (Fin and Rudder)	50 per cent Gottingen
Fin Setting	0 deg.
Incidence of Stabilizer	+4 deg.
Stabilizer Adjustment	+2½ deg. in flight
Total Wing Area, Incl. Ailerons	1110 sq.ft.
Center Section	207 sq.ft.
Wing Panels (2) Incl. Ailerons	903 sq.ft.
Total Aileron Area Aft of Hinge	110 sq.ft.
Total Vertical Tail Area	54.95 sq.ft.
Center Lower Fin	14.75 sq.ft.
Rudders (2) Incl. Balance	40.2 sq.ft.
Balance on Each Rudder	3.3 sq.ft.
Total Horizontal Tail Area	135.5 sq.ft.
Stabilizer	81 sq.ft.
Elevator	54.5 sq.ft.
Useful Load	7815 lb.
Crew—Pilot, Mechanic	340 lb.
Fuel and Oil	2025 lb.
Radio	180 lb.
Pay Load	5270 lb.
Passengers (20 @ 170 lb.)	3400 lb.
Mail and Baggage	1870 lb.
Weight Empty	9785 lb.
Structure	5590 lb.
Power Plant Complete	2556 lb.
Fixed Equipment	1639 lb.
Gross Weight	17,600 lb.
Wing Loading	15.8 lb. per sq.ft.
Power Loading	15.3 lb. per hp.

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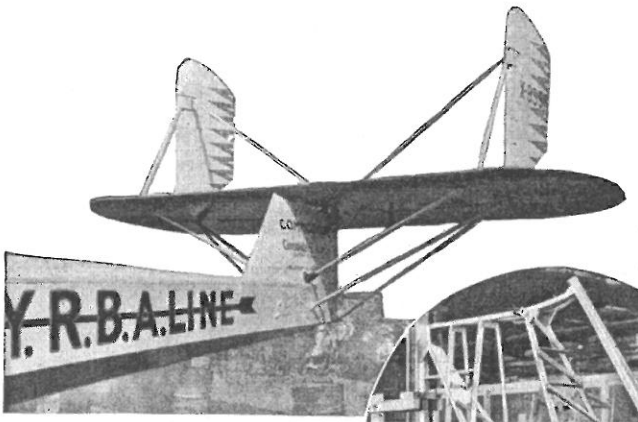
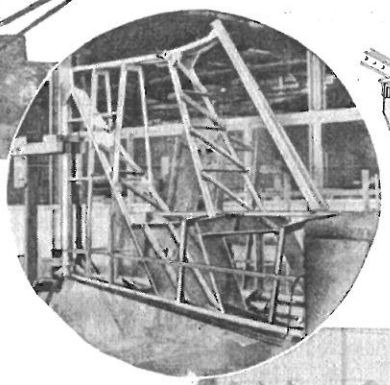
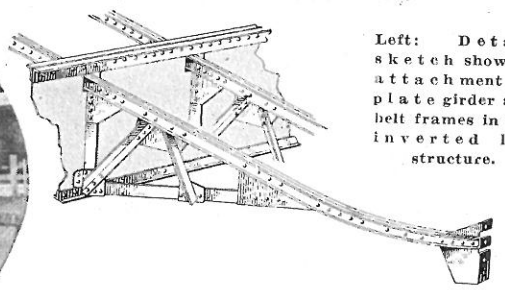
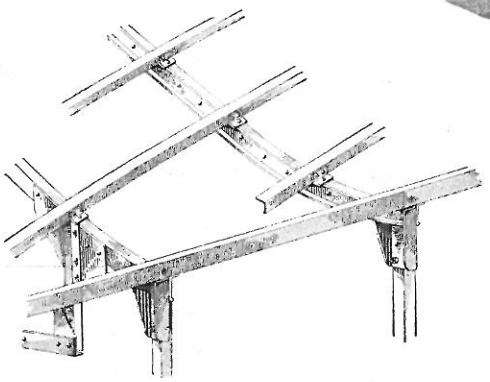




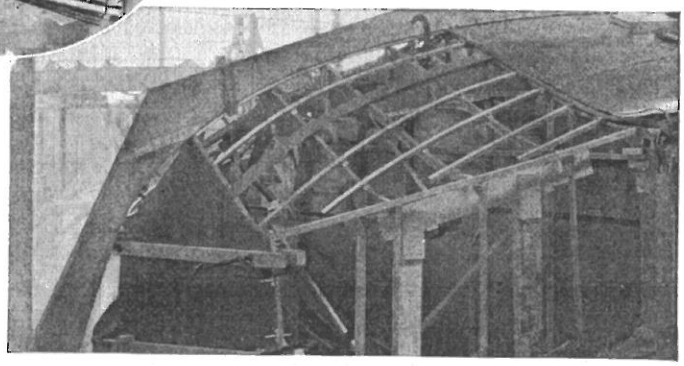
Above: The tail group of the Commodore showing the externally braced monoplane stabilizer and double rudders. Right: The fin structure showing its attachment to the tail.



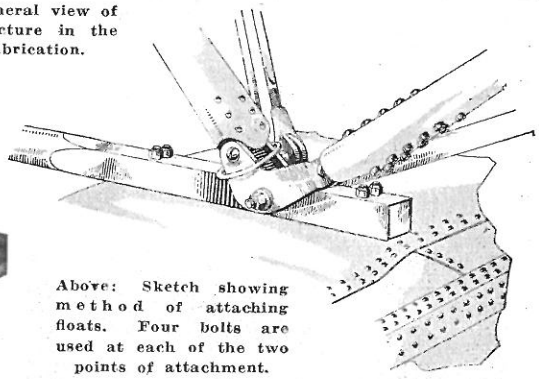
Left: Detail sketch showing attachment of plate girder and belt frames in the inverted hull structure.



Above: Sketch showing attachment of longitudinal to transverse members in the inverted hull structure.

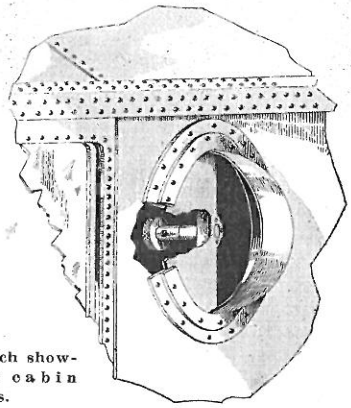


Above: A general view of the hull structure in the process of fabrication.



Above: Sketch showing method of attaching floats. Four bolts are used at each of the two points of attachment.

Above: A close-up of the port float of the Commodore. One of the cabin ventilators can be seen just behind the rear compartment windows.



Right: Detail sketch showing installation of cabin ventilators.

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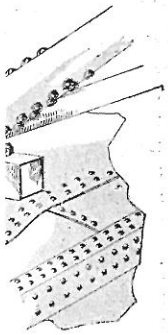
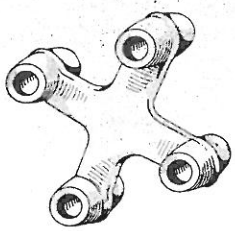
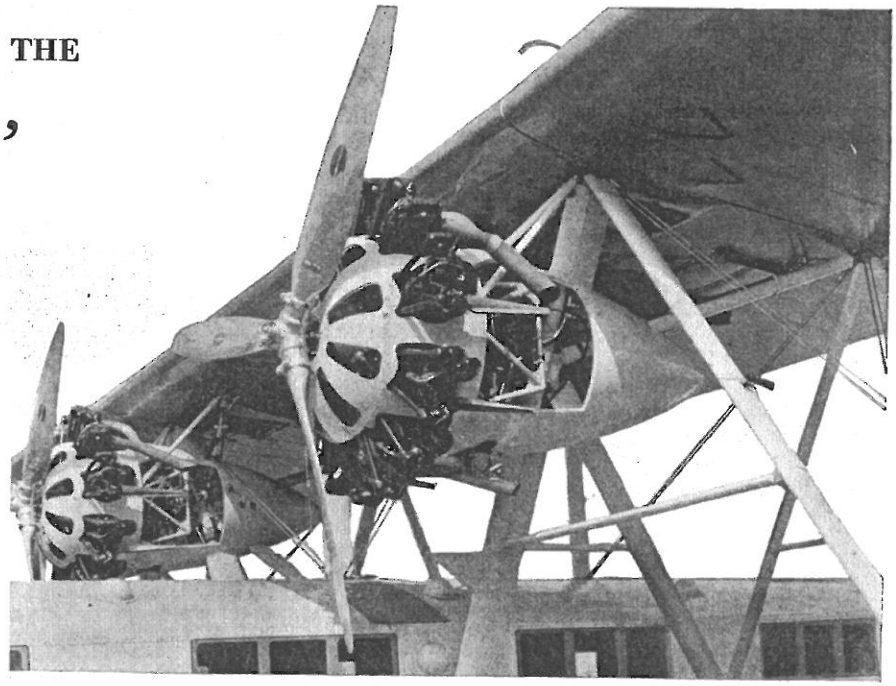
Left: Detail sketch showing attachment of plate girder and belt frames in the inverted hull structure.

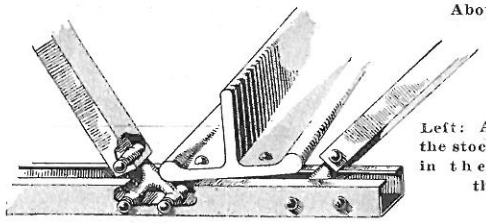




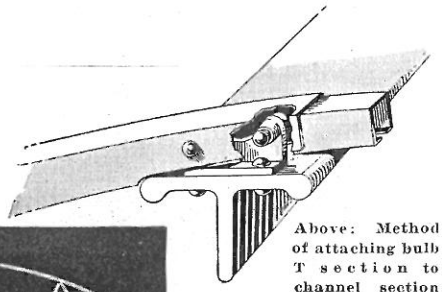
Above: One of the stock forgings used in the wing construction.



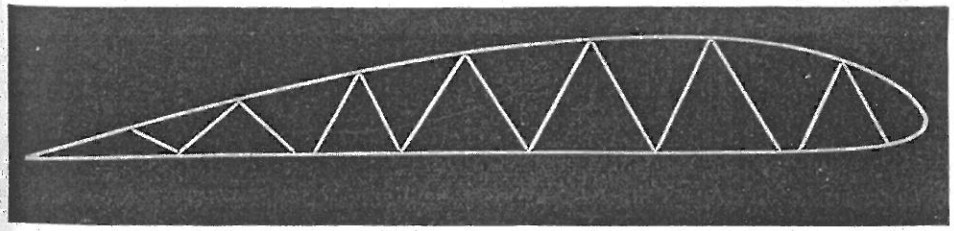
Above: Close-up showing external wing bracing and power plant installation.



Left: Applications of the stock forging used in the structure of the wing.

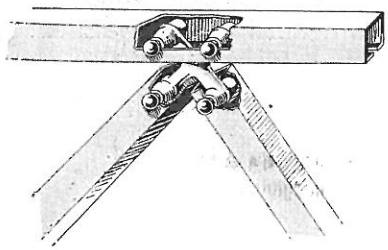


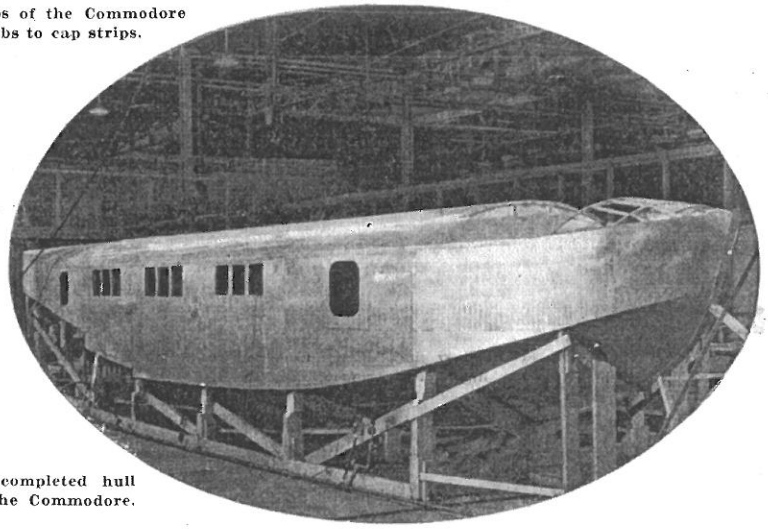
Above: Method of attaching bulb T section to channel section member.



Above: One of the Gottingen 398 metal wing ribs of the Commodore in which the stock forging is used to attach webs to cap strips.

Below: Use of the stock forging in the construction of the rib.





Right: The completed hull structure of the Commodore.